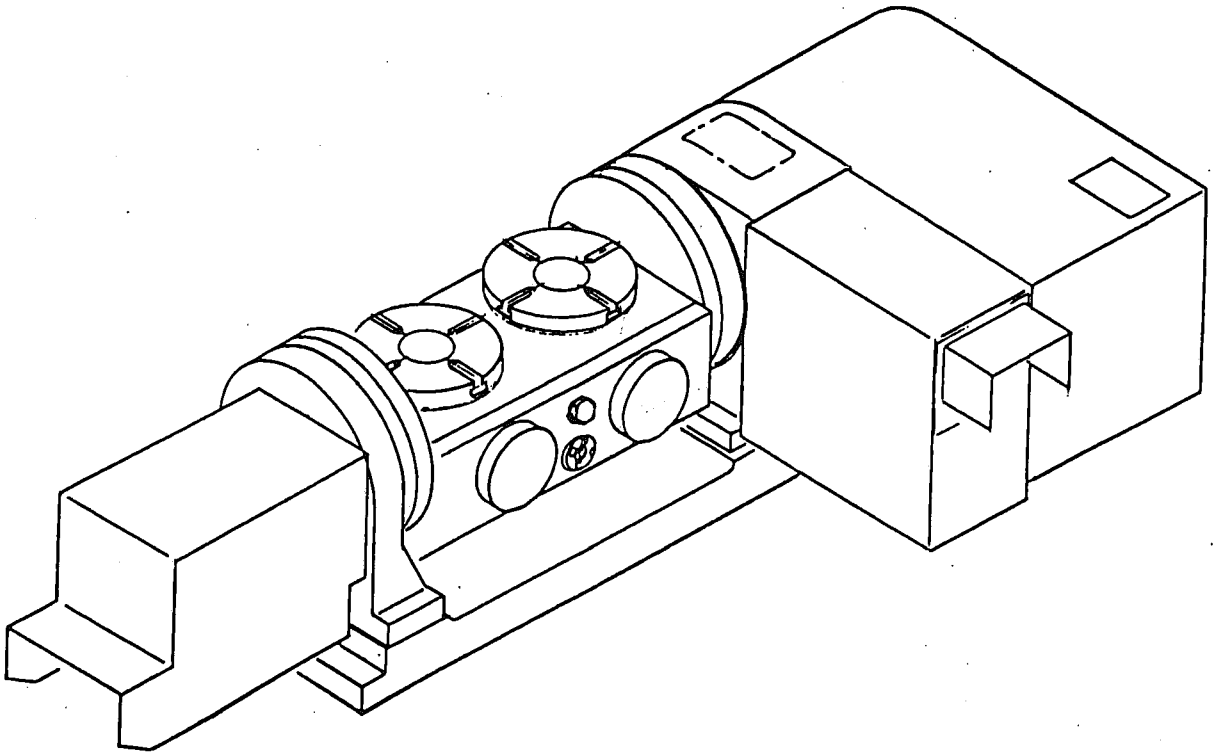
NIKKEN CNC circular Table

Automatic Tilting Multi-spindle Type

5AX－2MT－170

Individual Instruction Manual

First Edition



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1. Preface

Thank you much for purchase of NIKKEN CNC Circular Table.

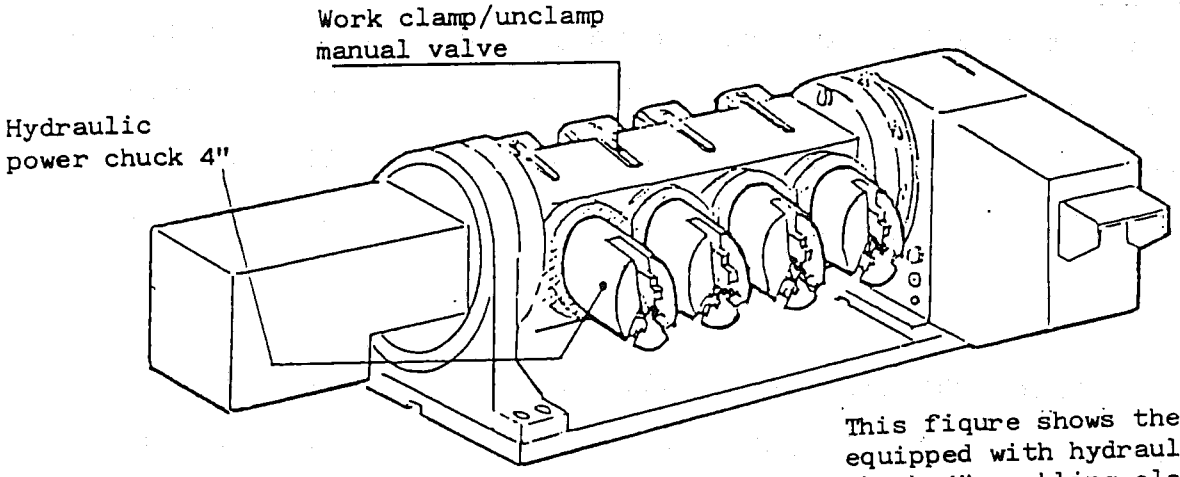
NIKKEN CNC Circular Table is designed and manufactured on the basis of our spirit of "every-day research", which words are the origin of our company name, and customers' intention is incorporated in the design to a maximum practical extent. We are sure that this Table will satisfy you for its high performance, high quality and easy operation.

NIKKEN CNC Circular Table withstands long-term and full operation. In order to ensure its proper handling and full utility for the intended purpose, please read the instruction manuals attached hereto.

We appreciate our connection with you through NIKKEN CNC Circular Table and wish to enroll you in our customer list for future service activities. Please fill and mail the attached post card to us.

Please keep "Inspection Table", "Common Instruction Manual" and "Individual Instruction Manual" in your file.

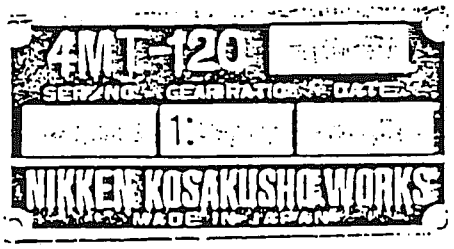
Various types (including attachments) other than the standard 5AX-4MT-120 and 5AX-2MT-200 are also available on your request. As for the single-purposed controller enabling all the circular table works with only one M-signal, please consult us freely since we have many experiences and gave actual results.



This fiqure shows the 5AX-4MT-120 equipped with hydraulic power chuck 4" enabling clamping/unclamping of work individually.

Fig. 1

If there should happen any trouble on the circular table, please advise us of all letters engraved on its name plate.

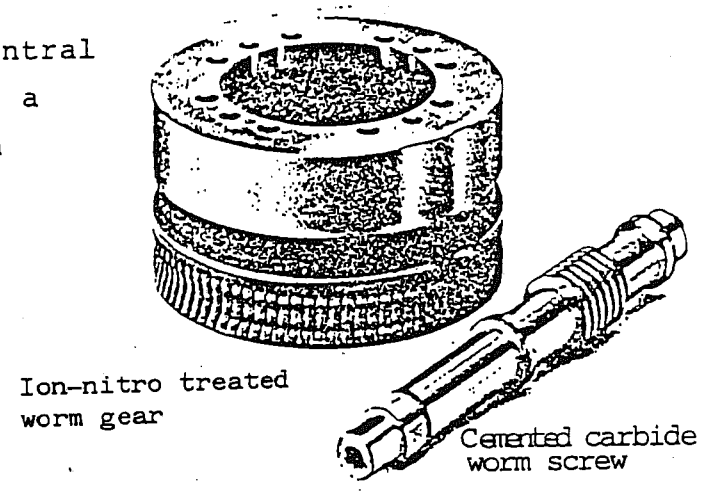


2. Characteristics of NIKKEN CNC Circular Table

NIKKEN CNC Circular Table has the following substantial characteritics:

1. Prevention of gear wear and maintenance of precision of indexing

The important and central part of the table is a worm gear and a worm screw.



As shown in the above, the worm gear of specially hardened special alloy steel with its teeth of ion-nitro treatment is used for the central part of NIKKEN CNC Circular Table, together with the worm of patented super-hard alloy. The problem of slip friction, therefore, is solved and their anti-wear quality is by far better than phosphor bronze and aluminum bronze.

2. Rapid feed speed

In the case of Model CNC-250 (F), the maximum number of revolutions is 166 R.P.M. The table for positioning, therefore, turns at a high speed of 20m/min. or above, when converted to its circumferential speed.

The above high speed results from the application of the special worm gear and worm screw as mentioned above, and the hollow roller bearing of high precision to the rotating friction part. Light torque and wear-free system is adopted and the mechanism of the table is free from a trouble.

3. Strong power of cutting

The worm gear and the worm screw are made of a combination of super-hard alloy and hardened steel, and have enough rigidity. In addition, the slip friction of tooth surface is made smooth by the special treatment of worm teeth. Consequently, strong and continuous cutting is ensured.

Also, the powerful hydraulic brake mechanism is employed so that strong and effective positioning is ensured to enable heavy duty cutting.

4. Easiness to use

Many attaching jigs conforming to all types of work pieces are available to enable easy work change with simple handling. (Refer to "Special accessories".)
Thanks to brake solenoid valves for both the tilting axis and rotating axis incorporated in the table, connection

works of hydraulic piping etc. become easy.

Optimum combination of machining devices including the attachments may be examined and discussed according to work pieces to be machined, convenient machining system become available.

5. Improvement in productivity

Ordinary ATC time is around 20 seconds for tip-to-tip, however, in case of the 5AX-4Mt type the ATC time per one work piece can be shortened to about 5 seconds (a fourth) because four work pieces can be mounted. Therefore, in case where many cutting tools are required, the productivity is improved by a large margine. Since different work pieces can be machined at the same time even for the multiproduct with small-quantity production, the preparation time and ATC time are reduced to cause an improvement in productivity. Further, if mounted on the double-spindle machine, the multi-surface simultaneous machining becomes possible to provide further effective manpower saving (AS regards the pitch between tables for double spindle machine, please consult us.)

Moreover, the unmanned operation becomes possible when the automatic work changing system is employed (by numerically controlling the work clamp/unclamp operation)

in combination with a robot, an auto-loader etc.

6. Safety

Clamp/unclamp state of table is ensured by the incorporated pressure switch and sensor, so that errors due to coolant or chip can be eliminated to secure a highly safe machining work.

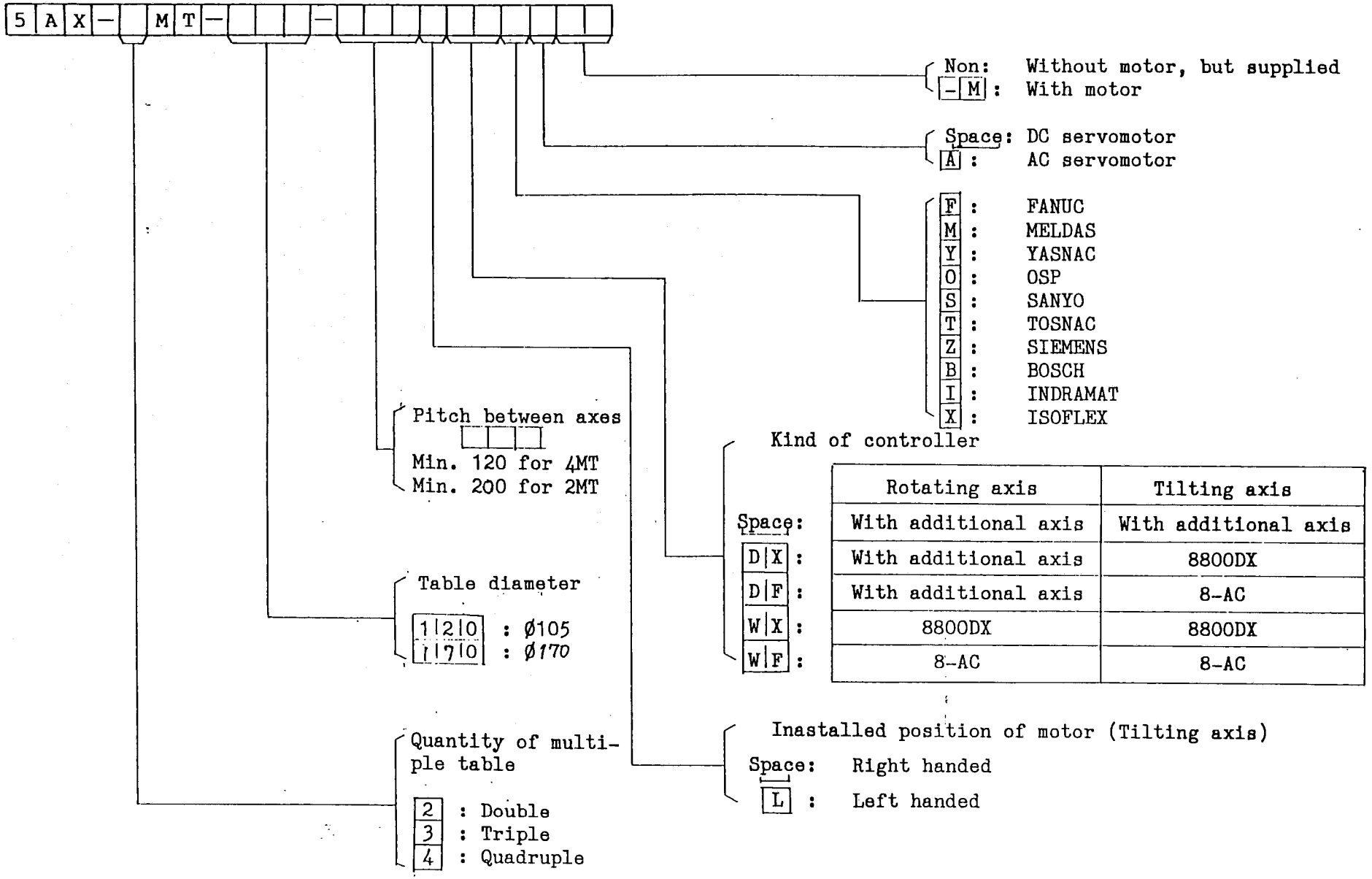
The +/- over-travel detection limit switch is normally provided in the tilting axis to cause the emergency stop of table in the event of emergency and prevent the table from accident and breakage due to run away.

7. Reliability

This circular table is most reliable not only in maintaining a high-precision but in heavy duty machining work. Further, as a countermeasure against water and moisture, careful consideration such as development of special seal is given thereto.

3. Specification

3-1 Basis of designating automatic tilting multiple-mount table



Kind of controller	Rotating axis	Tilting axis
Space:	With additional axis	With additional axis
D X :	With additional axis	8800DX
D F :	With additional axis	8-AC
W X :	8800DX	8800DX
W F :	8-AC	8-AC

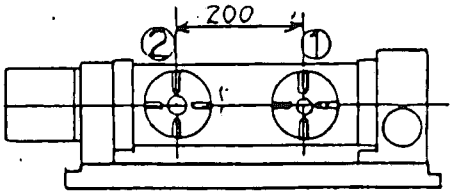
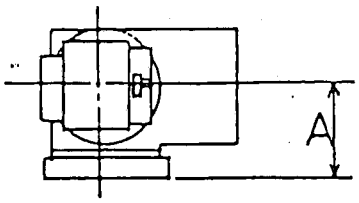
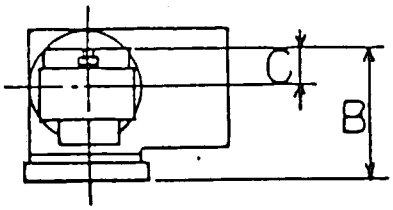
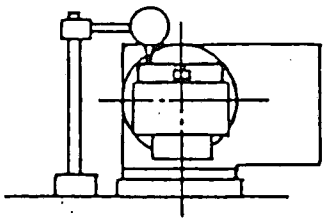
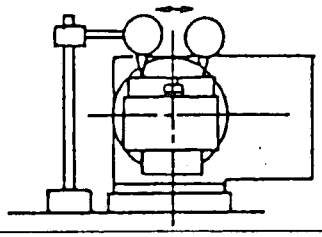
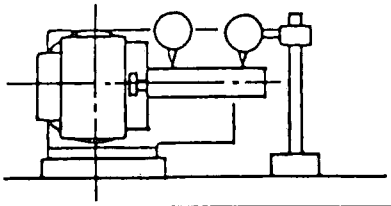
3-2 Specification

Axis	Item \ Type	5AX-4MT-120
Tilting axis	Table diameter	Ø250
	Max. rotation speed	rpm
	Angle of movement *1	220° -110° to +110°
	Braking force (at hydraulic pressure of 3.5MPa	1470Nm
	Minimum setting unit	0.001°
	Total reduction ratio	1 : 120
	Indexing accuracy	± 20 sec.
	Drive motor	FANUC AC 0S
	Detector	3000 PPR
Rotating axis	Table diameter	Ø 170
	Max. rotation speed	16.6 rpm
	Angle of movement *1	360° at will
	Braking force (at hydraulic pressure of 3.5MPa	196Nm
	Minimum setting unit	0.001°
	Total reduction ratio	1 : 12o
	Indexing accuracy	± 30 sec.
	Drive motor	FANUC AC S
	Detector	3000 PPR

*1 In case of special tables, the angle of movement would become small.

*2 In case of the OSP motor, the total reduction ratio will be different.

4. Accuracy standard

No.	Item	Location & method	Tolerance(mm)	Measured value(mm)		
1	Distance between axes		Within 200 ±0.015			
2	Height from bottom face to rotating axis center (A) (tilting axis center)		Within 0.02	No.1		
				No.2		
3	Height from bottom face to rotating axis table top face (B)		Within 0.02	No.1		
				No.2		
4	Runout of rotating axis table top face		Within 0.015	No.1		
				No.2		
5	Parallelism of rotating axis table top face		Within 0.02	No.1		
				No.2		
6	Runout of rotating axis table center hole		Root: within 0.015 150 mm from tip: within 0.03		Root	Tip
				No.1		
				No.2		
7	Indexing accuracy of tilting axis	Max. difference shall be measured by using wilied (swiss) optical index measuring machine	±30"			
8	Indexing accuracy of rotating axis	- ditto -	±20"			

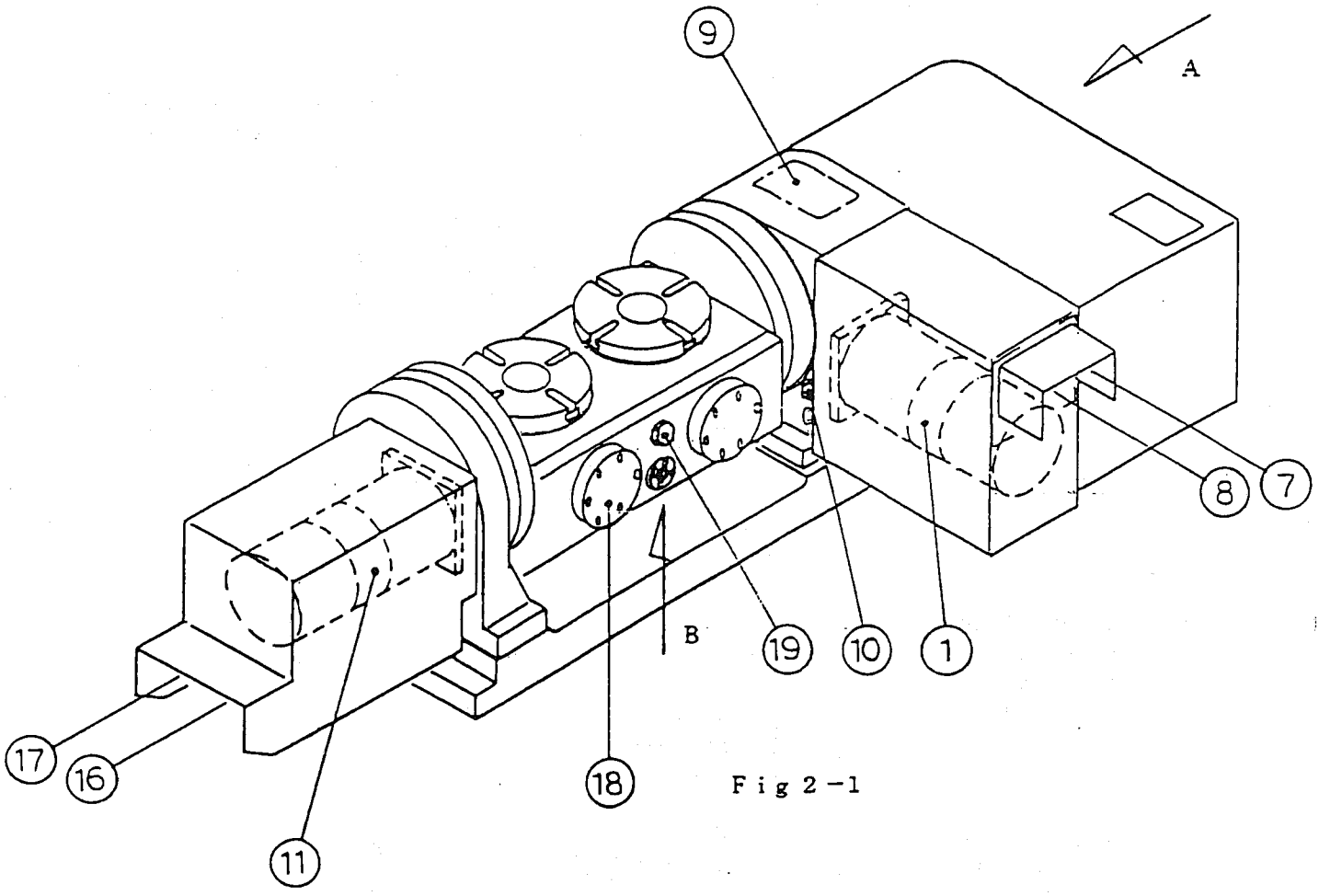


Fig 2-1

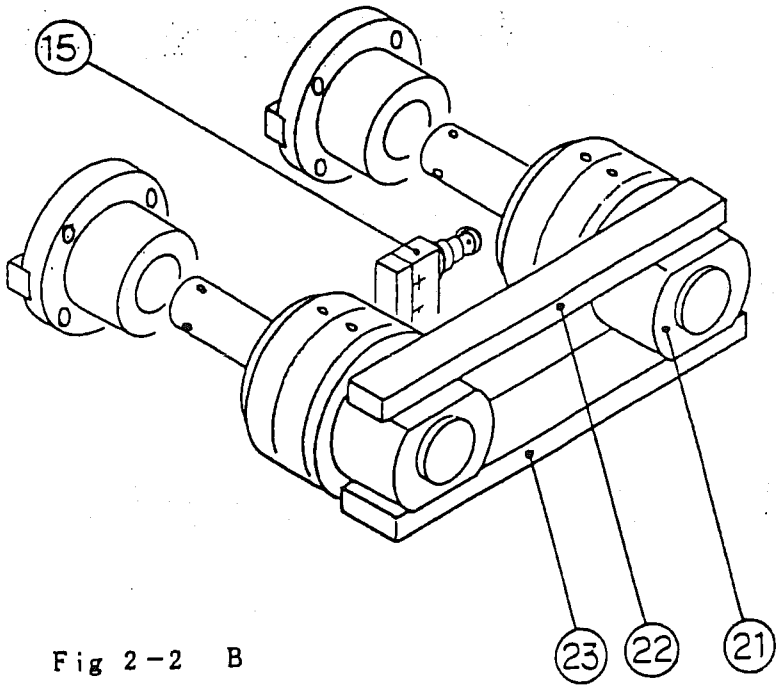


Fig 2-2 B

The tilting axis clamping solenoid valve, rotating axis clamping solenoid valve and work changing solenoid valve are disposed in the view A part.

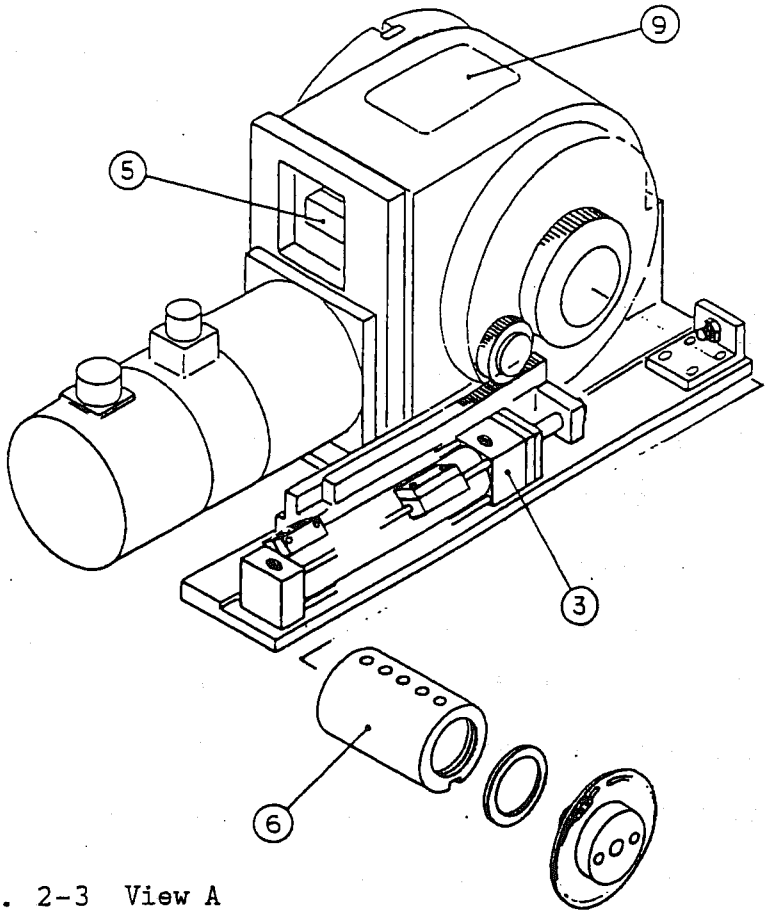
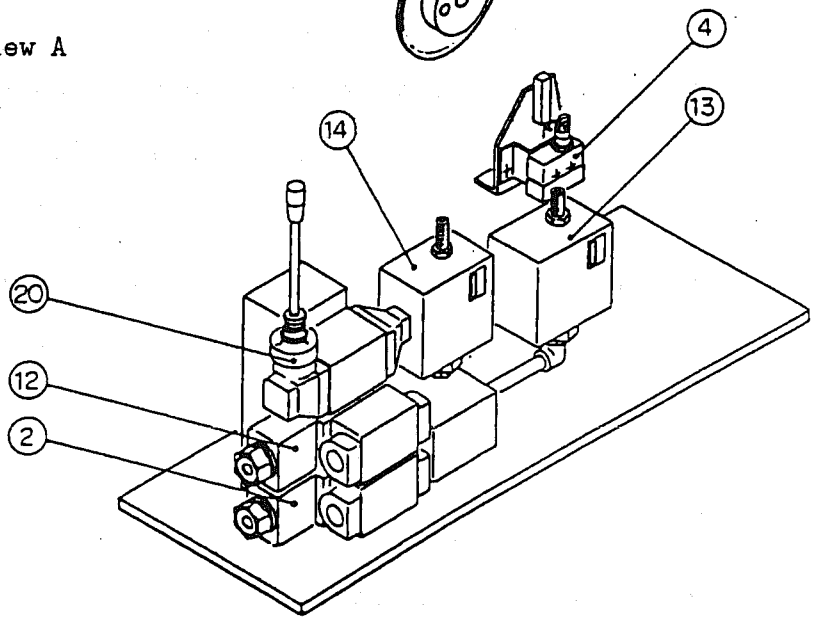


Fig. 2-3 View A



In NIKKEN tables, the standard tilting axis for 5AX-2MT-170 is CNC250 for hydraulic clamping and equipped with 5-port rotary joint.

① Tilting axis motor detector (equivalent to FANUC AC 0S, 3000 PPR pulse coder)

② Tilting axis brake solenoid valve

③ Tilting axis brake hydraulic cylinder with clamp/unclamp ensuring sensor

④ Tilting axis overtravel detection L.S.

⑤ Tilting axis zero-point return speed reduction L.S.

⑥ Tilting axis 5-port rotary joint

⑦ Tilting axis power cable connector

⑧ Tilting axis feedback cable connector

⑨ Tilting axis body oil filling port

⑩ Tilting axis gear box oil filling port

⑪ Rotating axis motor detector (equivalent to FANUC AC 0S, 3000 PPR pulse coder)

⑫ Rotating axis brake solenoid valve

⑬ Rotating axis clamp ensuring P.S.

⑭ Rotating axis unclamp ensuring P.S.

⑮ Rotating axis zero-point return speed reduction L.S.

⑯ Rotating axis power cable connector

⑰ Rotating axis feedback cable connector

⑱ Rotating axis clamping mechanism

⑲ Rotating axis body/gear-box oil filling port

⑳ Work changer manual valve

㉑ Work changer rotary joint

5. Preparation for operation

When operating the CNC circular table after purchasing, the next preparations and trial run etc. are necessary.

1) Unpacking, transportation and installation
2) Pouring lubricating oil
3) Supply of hydraulic pressure for clamp and air vent
4) Electrical connection
5) Trial run
6) Setting zero-point return grid amount
7) Example of program

5-1 Unpacking, transportation and installation

① Unpacking and transportation

Take careful attention for transportation after unpacking.

Pass wires through hook bolts and transfer the table carefully.

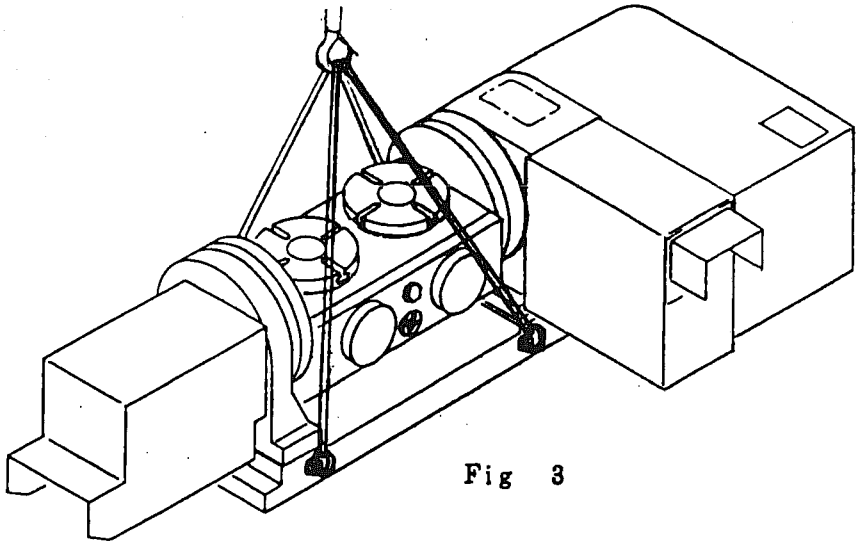


Fig 3

② Removal of rust-preventive oil

Carefully wipe off rust-preventive oil which has been applied on the entire surfaces of table before shipping. Avoid use of benzine and gasoline which may cause rust.

③ Installation

After installing the table, securely tighten it according to the method and installation holes as previously discussed.

Further, in case when the tilting axis is used in a range of 180° (-90° ~ $+90^{\circ}$), the rotating axis power cable and the feedback cable will be twisted so that a space of about 1 meter will be required at the rotating axis motor cover side.

5-2 Filling lubricating oil

Since the oil reservoir is of a totally enclosed type, mingling-in of coolant and leakage of lubricating oil will scarecely occur.

But, be sure to examine oil, inspect the oil pot every day and supply appropriate oil if necessary.
Oil filling ports are provided at three places: the tilling axis body, the gear box and the rotating axis body.

Incidentally, the oil filling ports have been fully supplied oil before shipping so that no lubricating oil is required to be filled at the initial state.

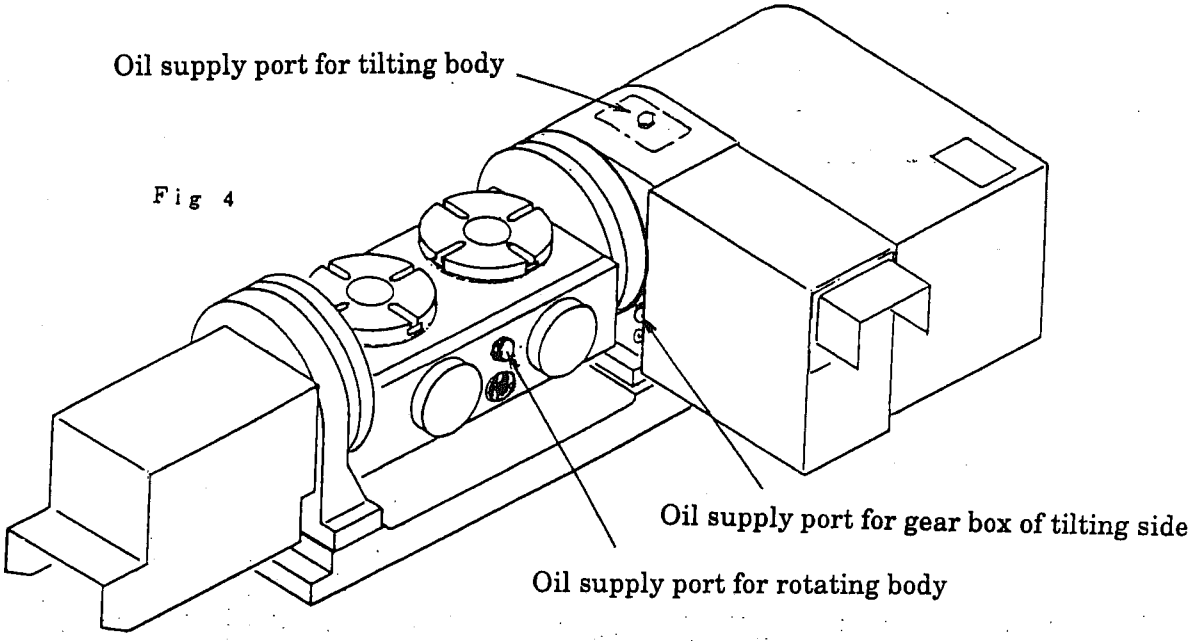
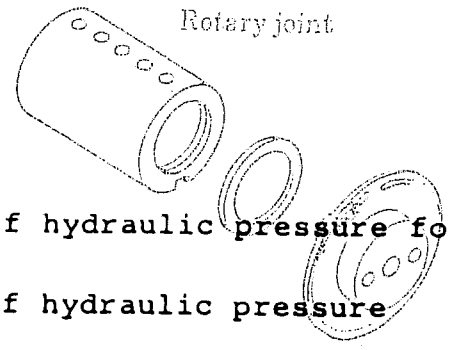


Fig 4

Recommended oil

Oil maker	Brand name
Idemitsu	Super mechanic oil 60~100
Kyodo sekiyu	Kyoseki letas 60~100
Maruzen oil	Swalub RO 60~100
Nippon sekiyu	FBK oil RO 60 ~ 100
Mitsubishi sekiyu	Dialub RO 60 ~100
Esso standard	Telesso 60 ~ 100
Shell oil	Shell telas oil 60 ~ 100



5-3 Supply of hydraulic pressure for clamp and air vent

① Supply of hydraulic pressure

Fig 5-1

All functions of tilting axis clamping, rotating axis clamping and work clamping are actuated by hydraulic pressure. Since the hydraulic circuit diagram will differ to some extent depending on the combination of devices employed, reference should be made to the attached hydraulic circuit diagram in details. The standard NIKKEN 5AX-2MT-170 will be described hereunder.

1) Hydraulic connection ports for tank and pump are provided at the right side of tilting axis CNC320V. The ports provide PT 3/8 fimale threads.

2) Use hydraulic pressure of 3.5MPa or less.

3) Avoid back pressure as far as possible (0.05MPa or less).

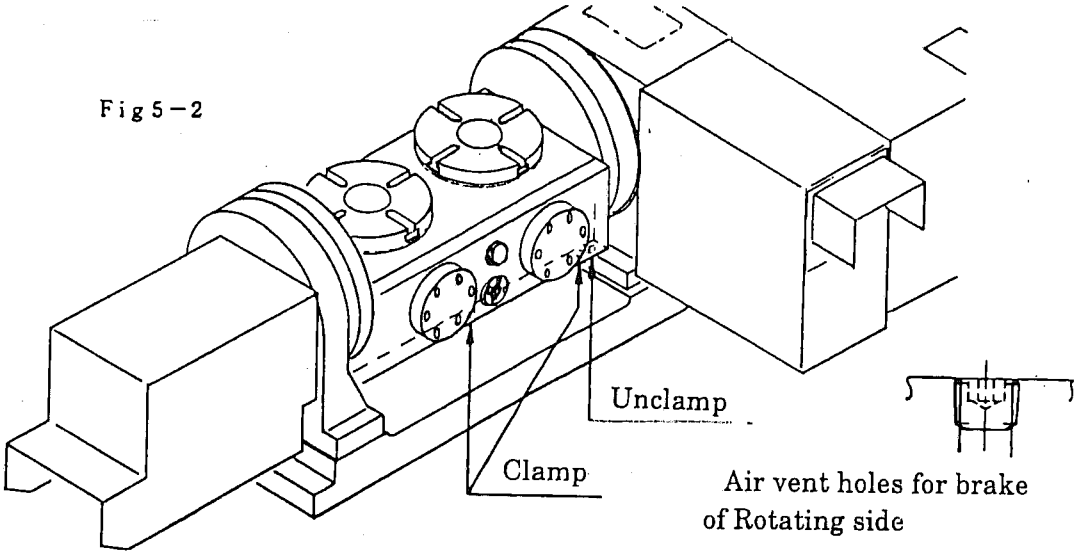
4) Normally, AC100V solenoid valves are provided for clamping the tilting axis and rotating axis, and a manual valve is provided for clamping the work.

5) Normal functioning states are as follows when the solenoid valves are energized.

Tilting axis: Unclamp

Rotating axis: Unclamp

Fig 5－2



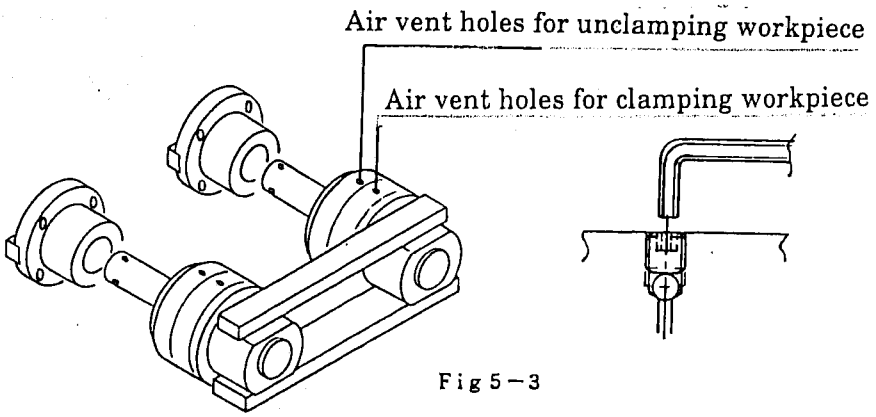


Fig 5－3

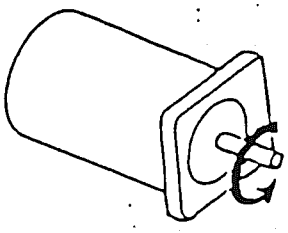
* The air vent hole for rotating axis is disposed at the side of the clamp/unclamp ensuring L.S. in the duplicate table unit cover. Pull out the PT1/8 plug first and loosen the screw at the inner part, then repeat clamping & unclamping operations.
When air is completely discharged, tighten the screw securely. Execute the air venting work from the tilting axis table CNC-320V side by turns.

Loosen the screw and pull and release the manual lever repeatedly. Tighten the screw securely when air is discharged completely. Execute the air venting work of work changer from the tilting axis CNC320V side one by one. When all the works have been completed, pull and release the manual lever from the tilting axis side again to ensure the air is completely discharged.

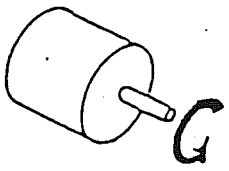
5-4 Electrical connection

For electrical connection with NC machine, refer to the attached electric connection diagram. Starting the table with the brake clamped would cause a breakage of table !

Viewing from the NC machine side, the motor and the pulse coder have been wired inside the motor cover so as to become the standard connection, unless otherwise specified.



Motor & tachogenerator

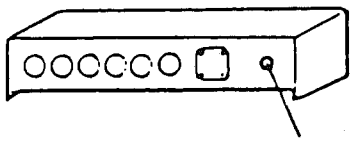


Pulse-coder

The tilting axis is equipped with the limit switch for preventing over-travel. Be sure to have the limit switch for preventing over-travel actuate by hand to check it emergency stop function after the electrical connection. Thereafter, be sure to ensure the function of over-travel bypass switch (to check that the emergency stop does not function when the limit switch for preventing over-travel is actuated with the over-travel bypass switch turned to ON as it is.)

The over-travel bypass switch is provided on the junction box in preparation for driving the tilting axis by the NIKKEN 8800DX.

Junction box



Over-travel bypass switch (red)

General electric connection diagram for 5AX-4MT-120WT in combination with hydraulic unit is shown in Fig. 6-1, and general electric connection diagram for 5AX-4MT-120DX in combination with hydraulic unit is shown in Fig. 6-2.

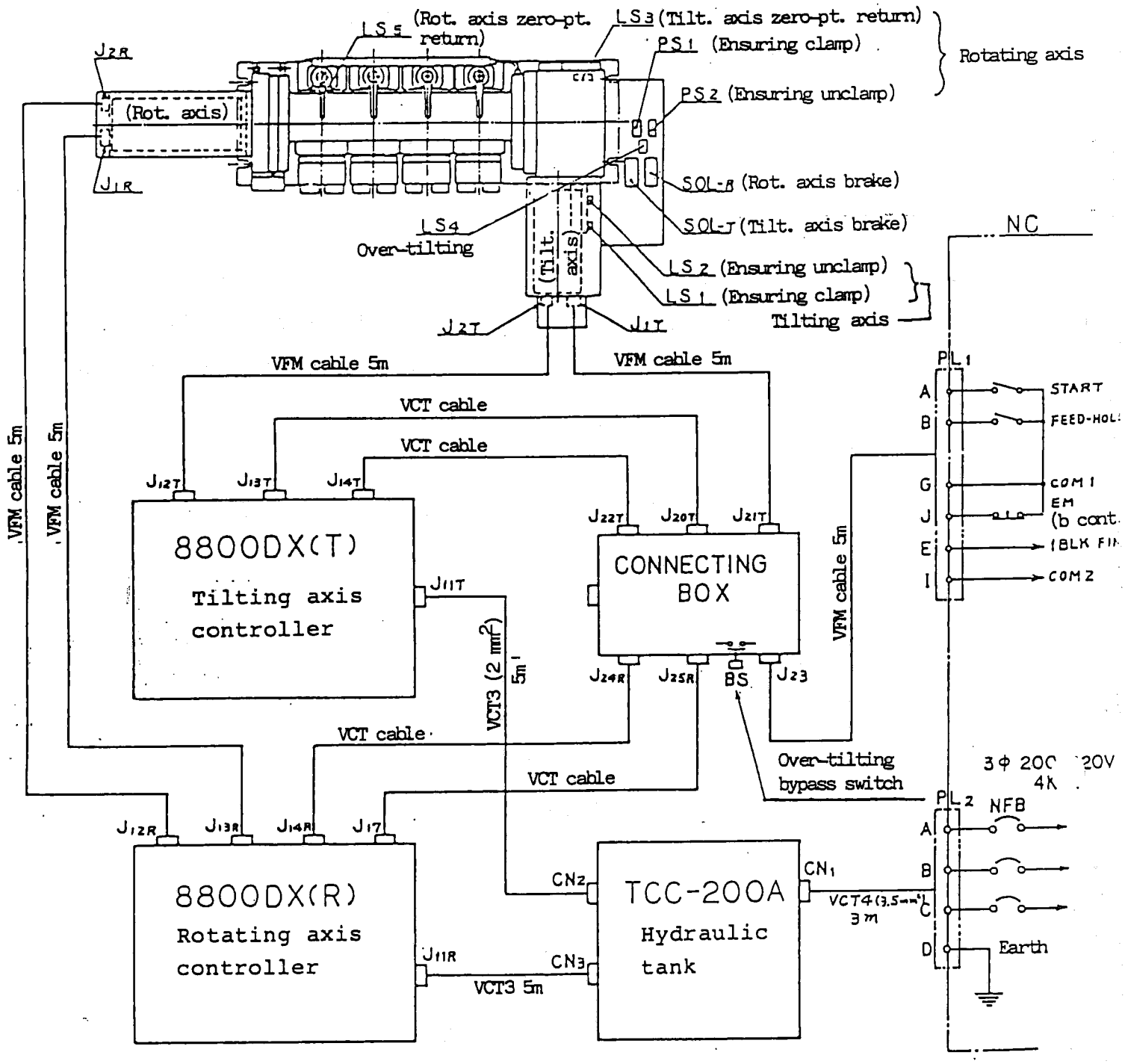
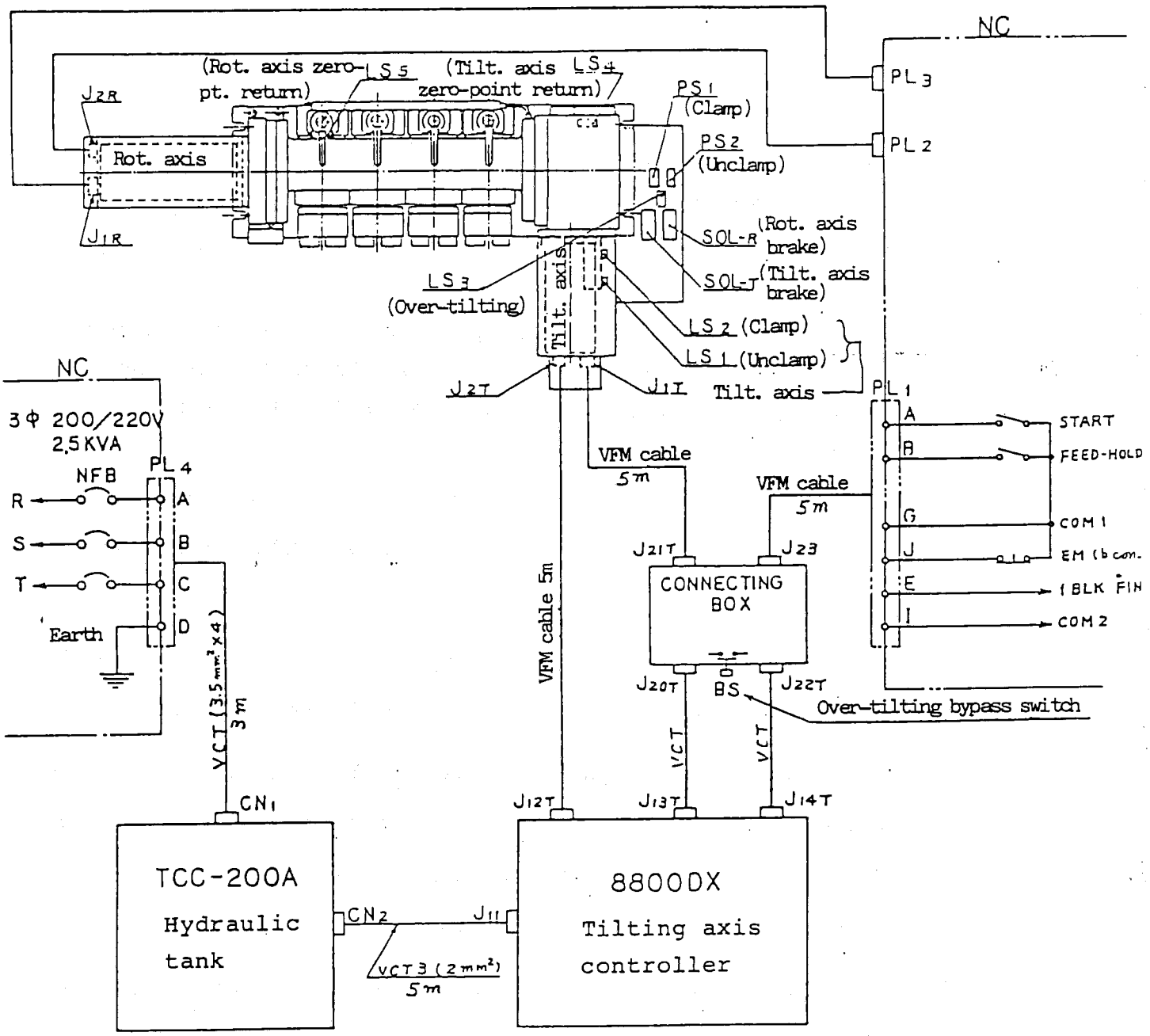


Fig. 6-1 General electric connection diagram for 5AX-4MT-120WT in combination with TCC-200A (hydraulic unit)



Note) PL4 receptacle, JIR & J2R straight plugs, PL2 & PL4 receplactes & straight plugs and cables connecting therebetween are not supplied.

Fig. 6-2 General electric connection diagram for 5AX-4MT-120DX in combination with TCC-200A (hydraulic unit)

5-5 Trial run

1) Connect hydraulic pressure to the table to make sure it is supplied correctly.

2) Do not install a work piece on the table to apply no load thereon.

3) Give the table brake clamp (M10, M68 etc.) and brake unclamp (M11, M69 etc.) signals alternatively and repeatedly from NC unit to make sure the brake functions normally.

When driven by the NIKKEN 8800DX, make sure by using the G10 (unclamp instruction) and G11 (clamp instruction).

```
NOOO      G10 G13 (unclamp, single operation mode)
NOO1 JOOO G11     (jump to NOOO after clamp)
```

4) Call relevant M code repeatedly in case of the automatic work change and repeat pushing and pulling of the lever in case of the manual valve, to make sure the work clamp/unclamp function is performed normally.

5) For the trial run of the rotating axis, carry out the break-in by making the axis rotate in both normal & reverse directions for about twice at a low feeding speed (about F360) to make sure of smooth rotation. Then, increase the rotation speed gradually.

For the trial run of the tilting axis, carry out the break-in by making the tilting axis rotate in both normal and reverse directions for about twice at a

low feeding speed while ensuring its position so as not to permit the axis enter into the over-travel region. Then, after ensuring the smooth rotation, increase the feeding speed gradually.

5-6 Setting zero-point return grid (required only for additional axis specification)

Zero-point positions of the tilting axis and rotation axis are shown hereunder.

* The zero-point position of tilting axis means the postion where the duplicate rotating table becomes horizontal (the work piece positioning at the topmost position).

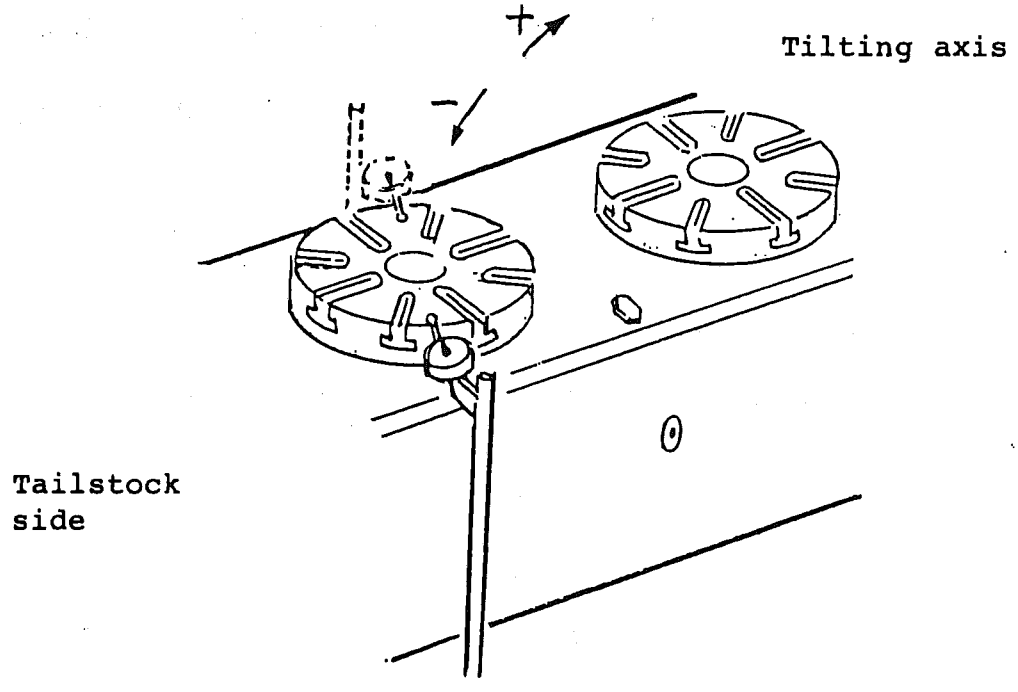


Fig. 7-1

* The zero-point position of rotating axis means a position where T-slots of duplicate rotating table become horizontal and the scale of base line plate indicates "0".

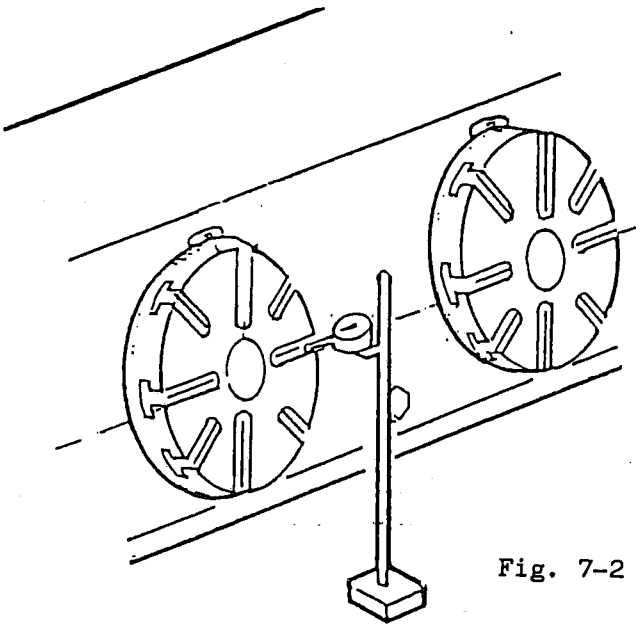


Fig. 7-2

The grid shift amount is written in the parameter table when shipping. Making the written value as a compensation value, execute the following steps.

① Enter the compensation value into the grid shift amount.

② Under "JOG" mode, move the axis about several degrees clockwise if it is rotating axis or move it to around 45° at the absolute position if it is tilting axis. Then, return the axis to the machine origin.

③ Check the zero-point position of table using the dial gauge and adjust the compensation value.

A compensation value, which is obtained by repeating the above procedures ① ~ ③ and ensuring the horizontalness, is the correct grid shift amount.

5-7 Example of program for trial run

The following is an example for driving both the rotating and tilting axes by the NIKKEN 8800DX (WX-type).

8800DX for rotating axis

G62: 8800DX for tilting axis start

G12: Consecutive operation mode

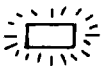
G13: Single operation mode

MAN mode 


```
N000              G12
   1 θ0.          G92 G91
   2 θ360 DIV6    FO
   3 θ15.
   4 θ30. F200
   5 θ15.  FO
   6 θ60.
   7 P3  Q6  L2   G27
   8 P3  Q5  L1   G27
   9 θ60.         G62

N010 θ360. DIV12
   1              G62
   2 θ90.
   3 θ-60.
   4 θ10.   F100
   5 θ120.  FO
   6 θ-30.  F150
   7 θ100.  DIV10  FO
   8 θ130.
   9              G62
N020              G62
N021              G62
N022    JO        G13
```

8800DX for tilting axis

AUT mode 


```
N000        θ315.

   1        θ270.

   2        θ250.

   3        θ100.

   4   JO   θ0.
```

For details of program, refer to the instruction manual of NC unit.

Now, the preparation for operation is completed. In practical machining, install the work piece and jig precisely to accomplish a stable machining.

6. Mechanism and adjustment of major functioning part

6-1 Adjustment of backlash (tilting axis)

The worm shaft rotates in the totally-enclosed oil bath and the reduction mechanism is composed of a combination of the special ion-nitrided worm gear and the carbide worm screw, so that it is not necessary to adjust the backlash until four to five years have elapsed after the table is put in service.

However, if necessary, the backlash can be adjusted easily according to the following procedures.

1) Return the rotating axis to its zero-point and clamp it (brake: ON).
2) Return the tilting axis to its zero-point and open the brake.
3) Ensuring the backlash

Read a deffection of the dial gauge Ⓖ by inserting a flat steel plate Ⓗ into a T-slot and shaking the table left and right through the plate with hand.

Be sure, in this instance, to keep the dial gauge Ⓖ in cantact with the T-slot. A backlash of within 5 ~ 15 μ is normal, and the adjustment is required in the event when a backlash of above 0.05 mm is observed.

The adjustment is to be done on the following five spots:

0° (zero-point), 45°, 90°, $-45^{\circ}(315^{\circ})$ & $-90^{\circ}(270^{\circ})$

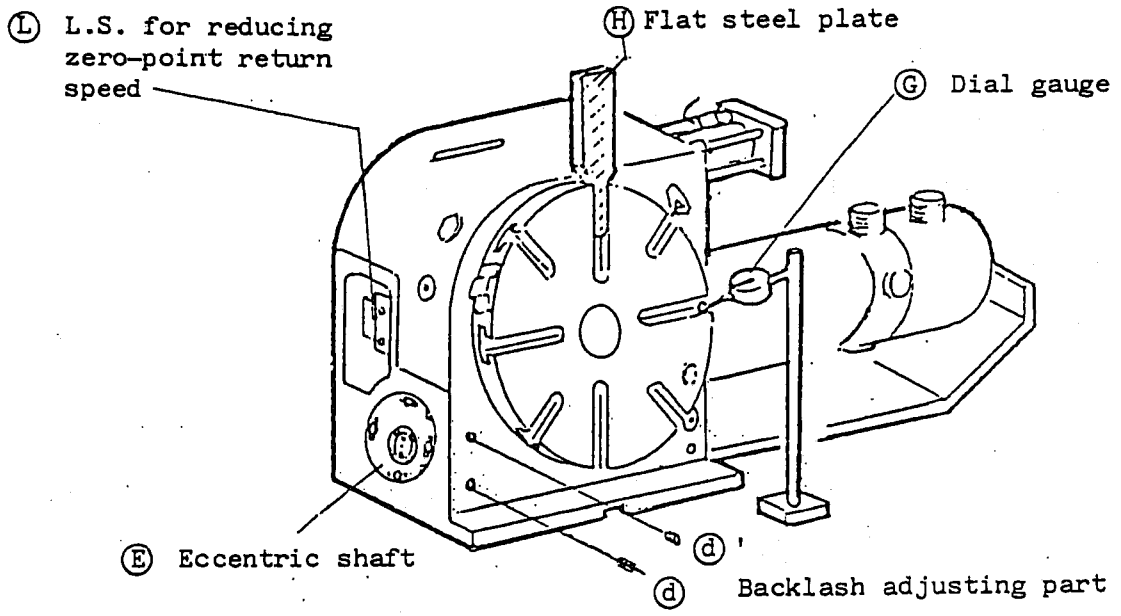


Fig. 8

6-1-1 Adjustment of backlash between worm gear and worm screw

1) Loosen four cap screws which fasten the eccentric shaft Ⓔ.

2) Take out the screw plgs ⓓ and ⓓ' of Fig. 2 and the backlash adjusting bolts ⓗ & ⓖ will be provided therein.

3) Here, reset the dial gauge Ⓖ as shown in Fig. 4,

loosen the screw ⓗ and tighten the screw ⓖ clockwise, then the eccentric shaft will turn in the direction of arrow. Thus, the backlash between the worm gear and the worm screw will get near to zero. Adjust the backlash to 10 ~ 15 μ by using the screws ⓖ & ⓗ watching the deflection of the dial gauge Ⓖ while shaking the outer periphery of circular table, then securely lock them again.

4) After completion of the above adjustment, tighten the plugs ⓓ & ⓓ' and bolts for the shaft Ⓔ.

5) Measure the backlash again and ensure that the backlash is adjusted to 5 ~ 10 μ.

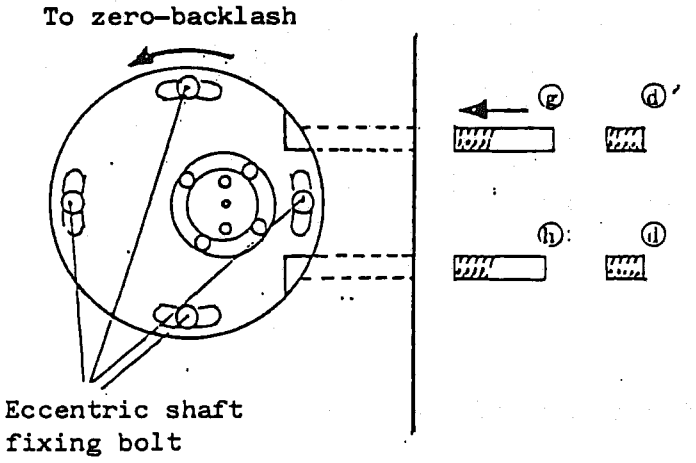


Fig. 9

6) After completion of the adjustment of backlash, make sure of the motor load. Turn on the power supply, let the circular table rotate on the jog mode to check the motor shaft for gear noise.

* If abnormal sound is recognized, loosen the attaching bolt of Fig. 10 and slowly turn adjusting screw clockwise, then it will become normal sound.

* If the gear noise is too light as compared with former one, a backlash would have been produced in the motor shaft.
  Apply the dial gauge Ⓖ on the T-slot again as shown in Fig. 8 and jog the button to examine behavior of the gauge pointer. Turn the adjusting screw counter-clockwise while operating both the CW & CCW jog buttons, and the backlash of the motor shaft will get near to zero.

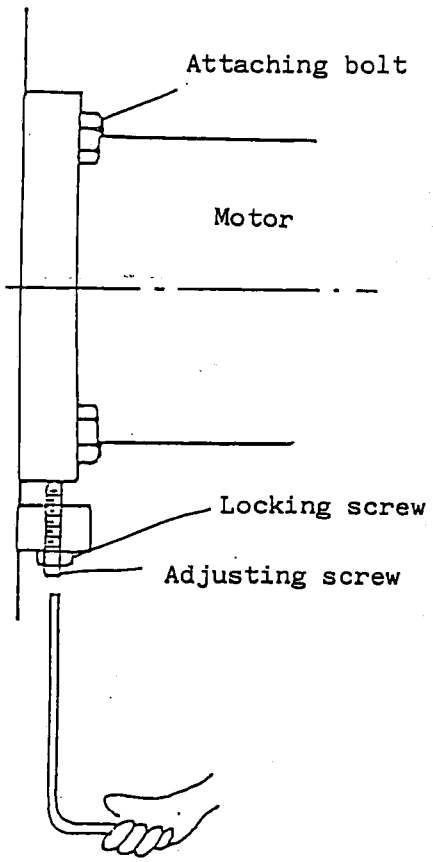


Fig. 10

Cautions:

1. The adjustment of backlash is a very delicate work, so be careful when executing it.
2. Completely seal the threads of plugs ⓓ & ⓓ' using a seal tape etc., without fail !
   Carefully check the seals because long-year's ingress of cutting fluid or oil from these plugs would cause various troubles.
3. Retighten the locking screw and the motor attaching bolt shown in Fig. 10.

6-2 Brake mechanism (tilting axis)

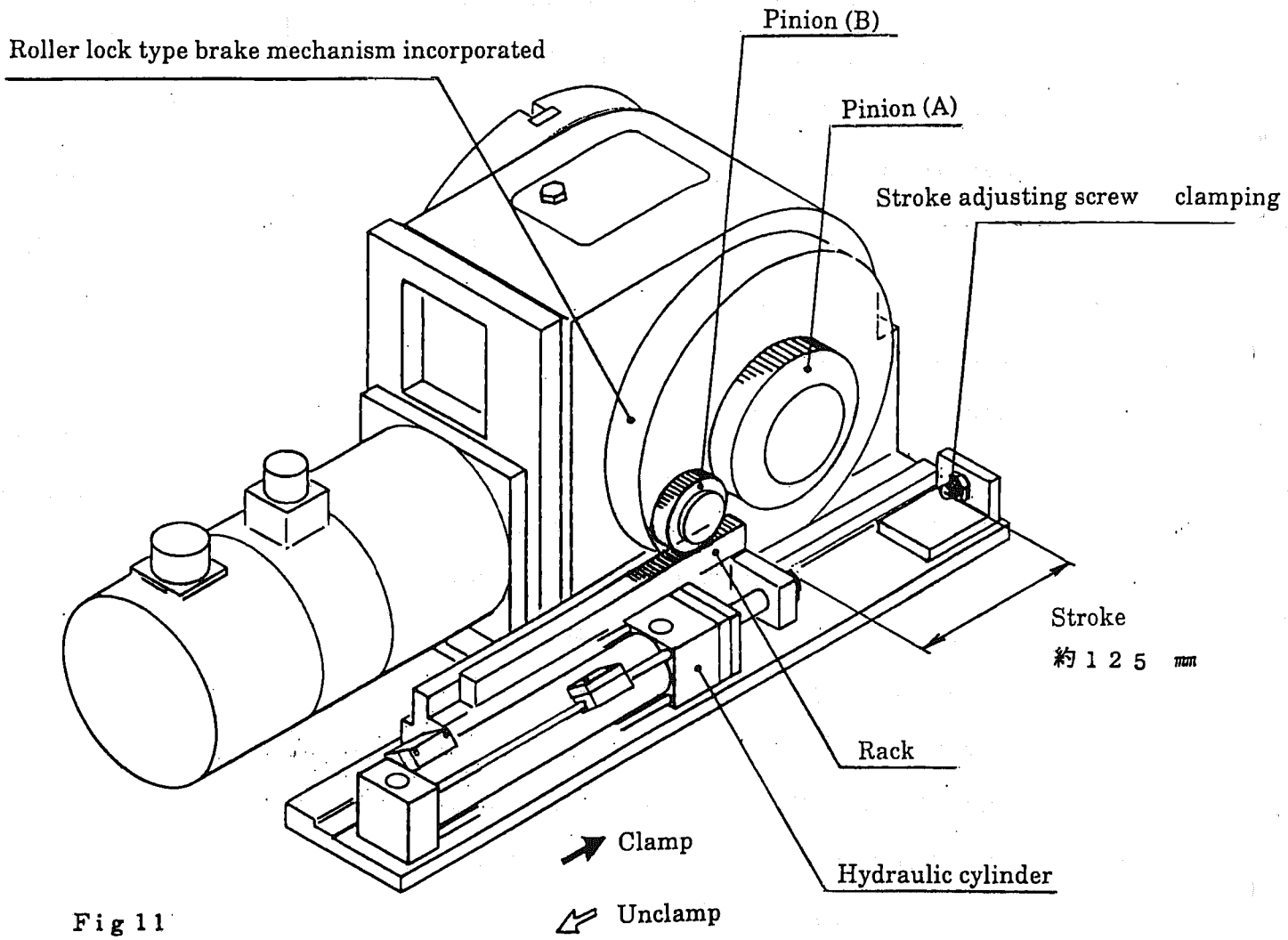


Fig 11

The rack fixed to the piston shaft is also moved forward, this forward movement of rack causes rotations of the piston (B) & (A). The tightening metal connected to the piston (A) Rotates to move the incorporated roller lock mechanism to clamp the tilting axis. The internal mechanism is similar to mechanism corresponding to the automatic type NIKKEN Multi Lock Chuck. The clamped state is ensured by two reed switches fitted to the clamp cylinder.

6-3 Clamp/unclamp ensuring mechanism (tilting axis)

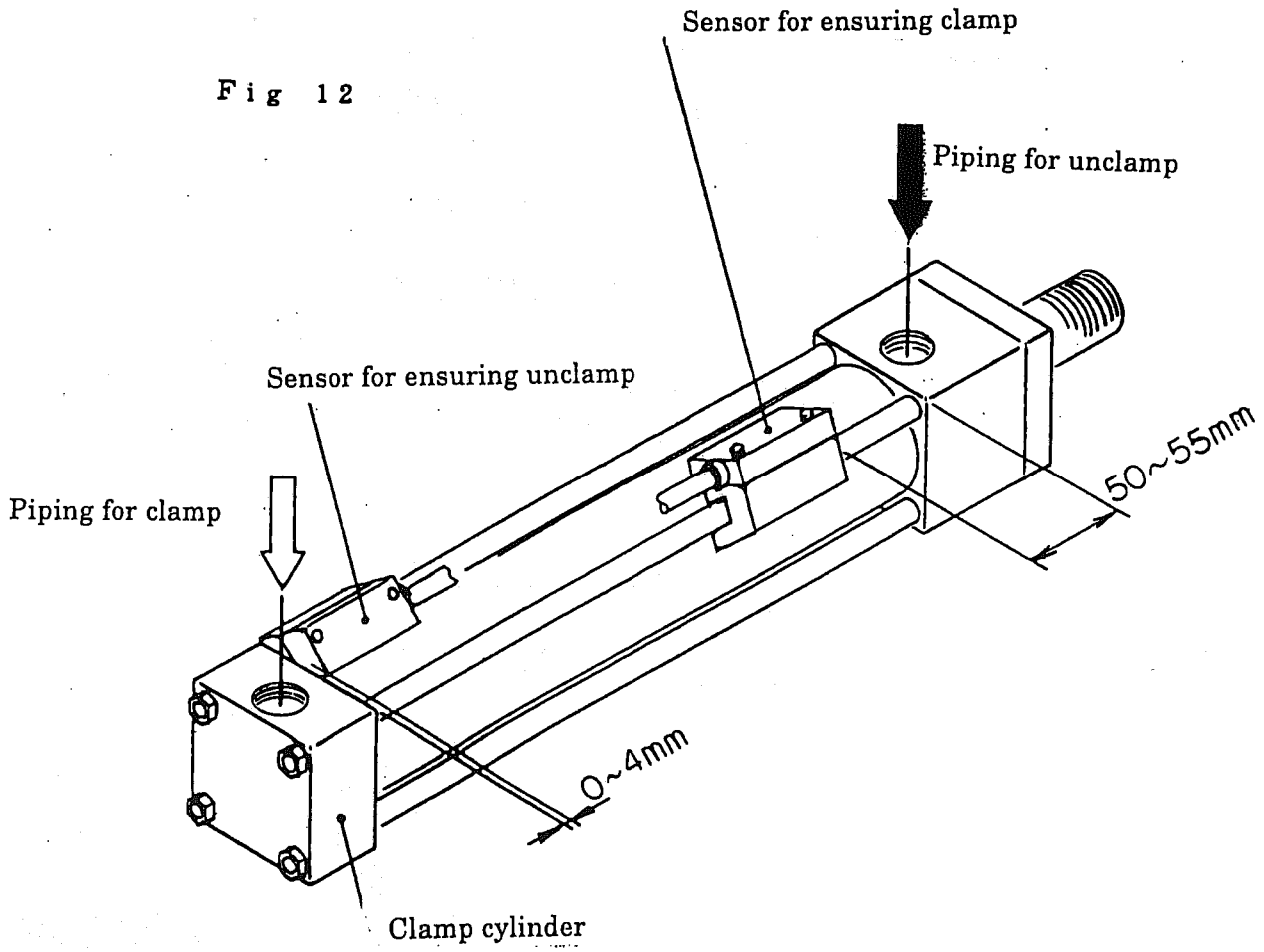
The sensors for ensuring clamp/unclamp are provided on the hydraulic cylinder as shown in Fig. 12.

The hydraulic cylinder is directly coupled to the brake rod, so that the clamp/unclamp ensuring sensors sense a movement of the magnetic generator in the cylinder to directly output a contact signal.

The unclamp ensuring sensor is positioned at 0 ~ 4 mm from hydraulic cylinder flange, and the clamp ensuring sensor is positioned at 50 ~ 55 mm therefrom.

In the event of wrong sensor positions with no trouble in the solenoid valve, brake etc., loosen the sensor attaching bolts and adjust the positions as described above.

Fig 12



6-4 Zero-point return mechanism (tilting axis)

1) The limit switch for zero-point return is disposed in Fig. 2-4. The dog attached to the outer periphery of table actuates this limit switch to have it output the speed reduction signal.

2) Adjustment of dog position

Bring the dog under the jog mode to a position where the adjustment can be done easily.

3) Loosen the dog fastening bolts, and shift the dog to a proper position (See Fig. 13.).

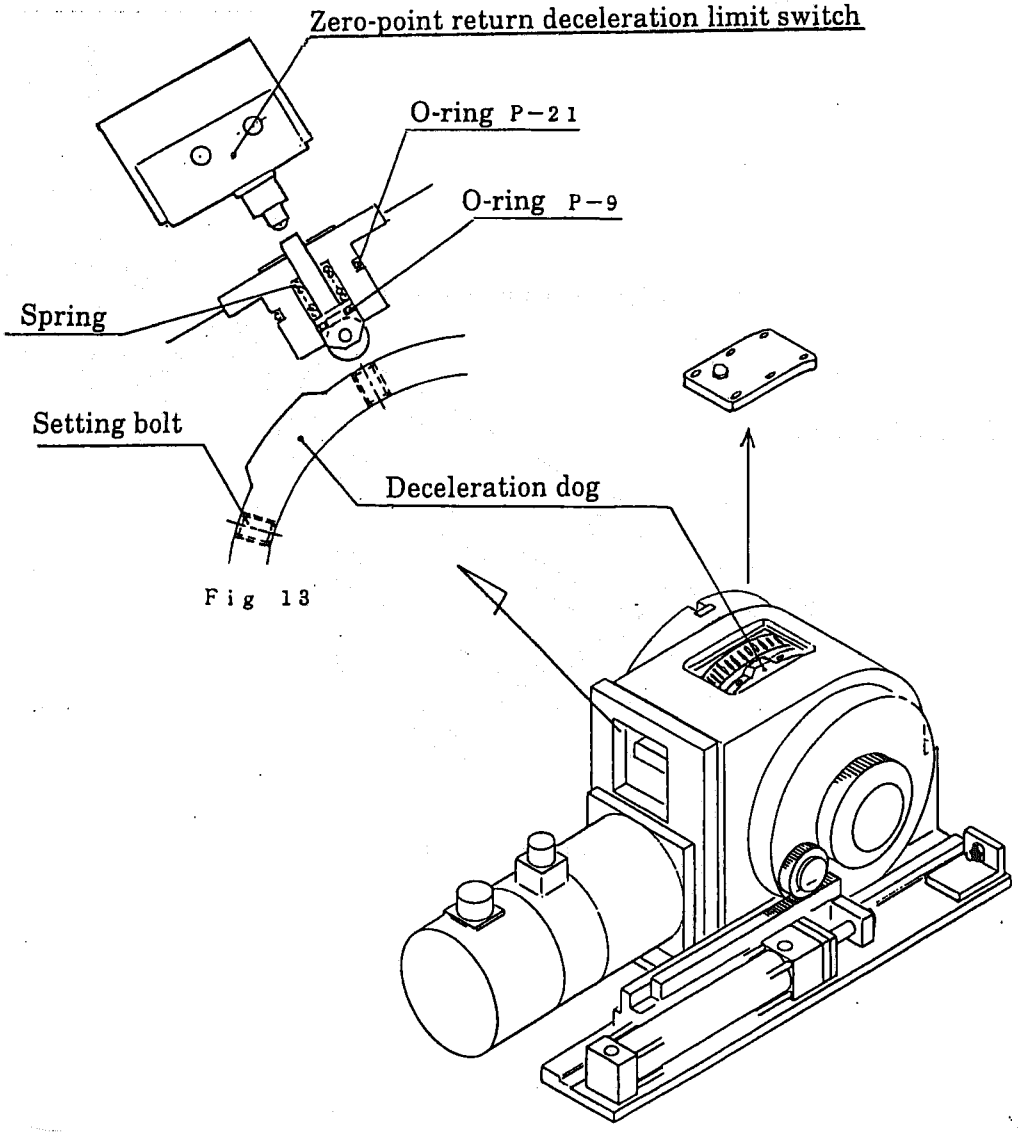


Fig 13

6-5 Over-travel prevention mechanism (tilting axis)

The moving range of machine for tilting axis CNC250 is $-110^{\circ}(250^{\circ}) \sim 110^{\circ}$ when a 120ø work is fitted. The dogs and limit switch for detecting over-travel are set on the CNC250 side so as to actuate at axis angles -112° (248°) and 112° respectively in consideration of the braking distance at the time of emergency stop (See Fig. 14.).

When the table is shipped, the software limit value for the tilting axis 8800DX in case of operating the 5AX-4MT-120 by the NIKKEN 8800DX has been set to 110.5° (PRM#33) for the plus side and 249.5°(PRM#34) for the minus side.

In the event when the software limit value is changed by customers, be sure to observe the following steps.

* Turn off the power for 8800DX.
* After waiting a little, turn the power on.
* Then, perform the M zero-point return operation by pushing the key [M ZRN] .

Further, change the parameter value of the parameter sheet (Individual function specification).

Take the following steps to release the emergency stop mode in general operation, although they may differ to some extent depending on an NC unit to be connected.

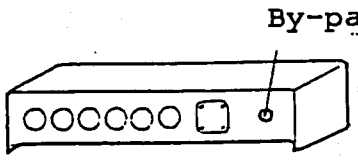
① Turn the power off.

② Turn the power on while the overtravel by-pass switch kept turned on, and move the table to the safety zone under the JOG mode.

③ Turn the overtravel bypass switch off, because the next overtravel can not be detected.

④ Return the table to the M zero-point.

In case of the NIKKEN 8800DX, the bypass switch is provided on the junction box. To release the emergency stop mode, take the same steps as described above.



6-6 Mechanism of rotary joint for tilting axis

The rotary joint is installed at the backside of the CNC250 for tilting axis.

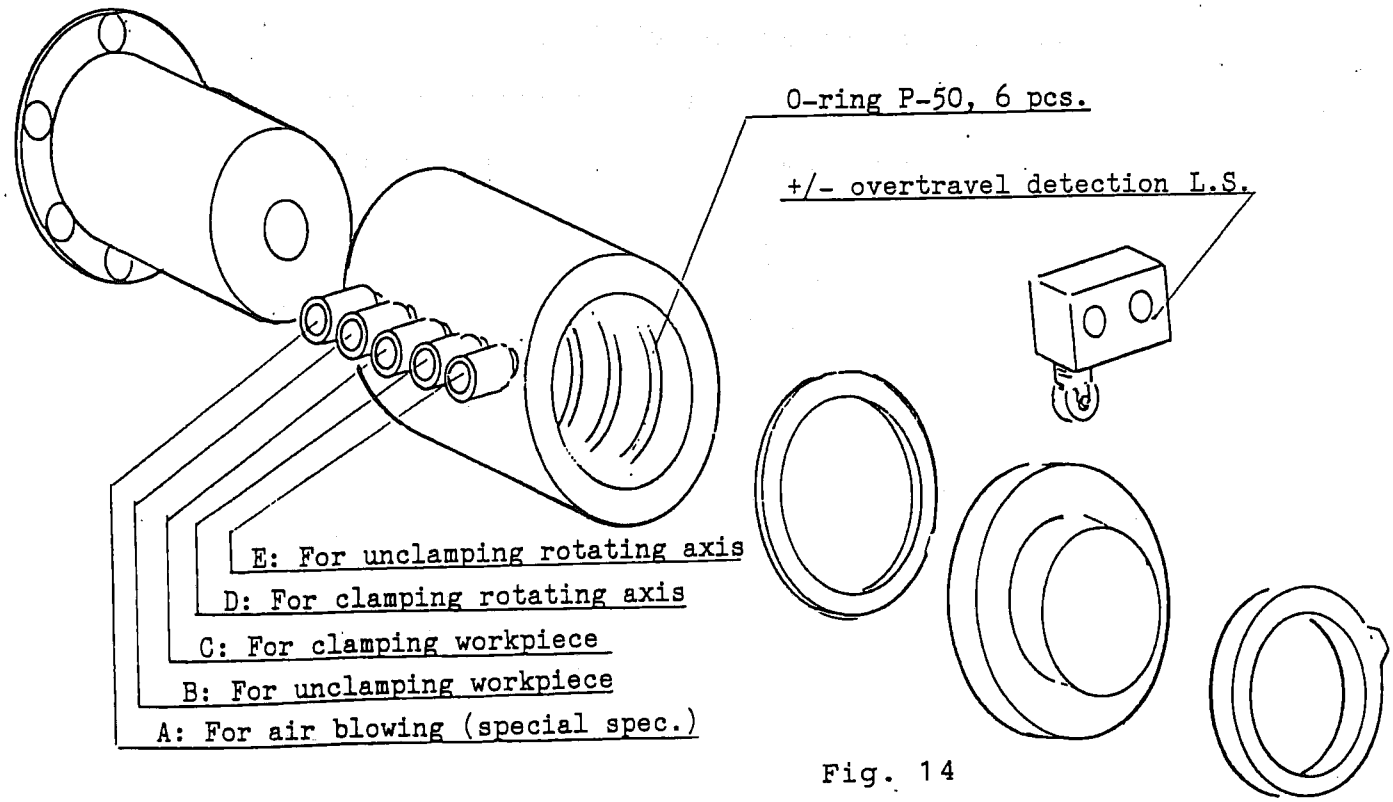


Fig. 14

6-7 Adjustment of backlash (rotating axis)

The worm shaft rotates in the totally-encrosed oil bath and the reduction mechanism is composed of a combination of the special ion-nitrided worm gear and the carbide worm screw, so that it is not necessary to adjust the backlash until four to five years have elapsed after the table is put in service.

However, if necessary, the backlash can be adjusted easily according to the following procedures.

1) Move the tilting axis to 90° position and clamp it (brake: ON).

2) Return the rotating axis to its zero-point and open the brake.

3) Measuring the backlash

Insert the flat steel plate (H) in the T-slot.
Read the dial gauge (G) while shaking the table outer periphery left and right with hand. A backlash of 5 ~ 15 μ is normal and the adjustment is required in the event when a reading deflection of 0.05 mm or more is observed. The measurement is to be done at eight places on every 45° for respective duplicate tables.

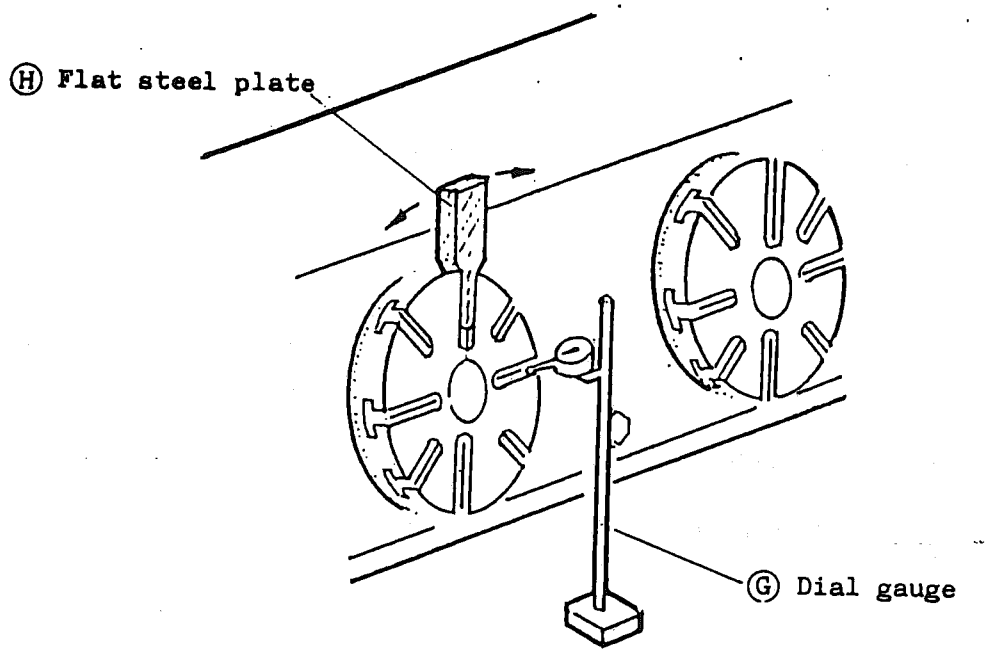


Fig. 13

6-7-1 Adjustment of backlash (rotating axis)

The backlash is adjusted by decreasing the inter-meshing pitch between the spindle center and the worm shaft center.

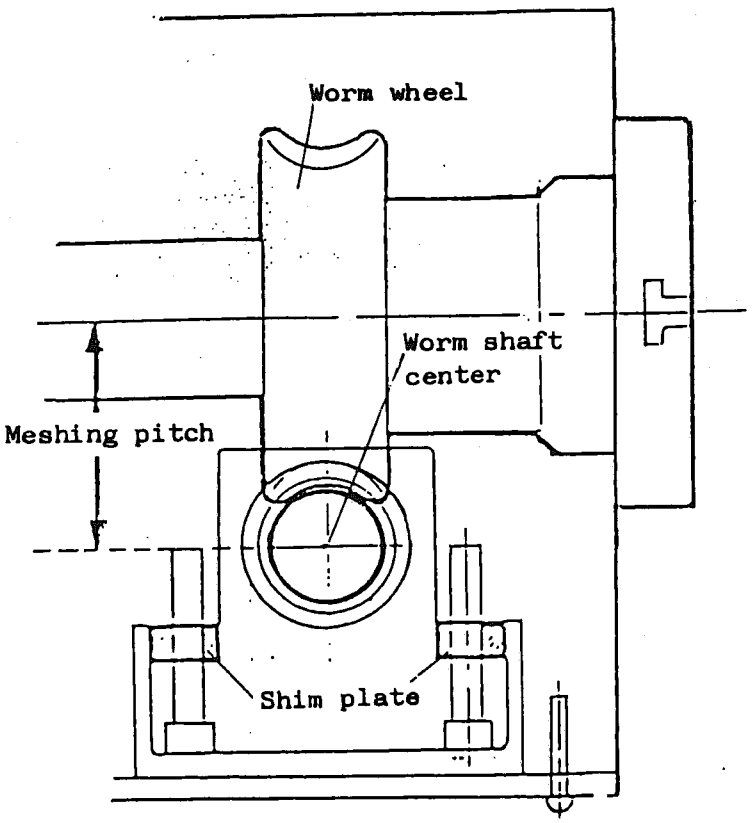


Fig. 14 Backlash adjusting mechanism of rotating axis

The adjusting mechanism is as shown by Fig. 14.
Take out the shim plates and thin them by a surface grinder etc. Thin the shim plate by about 0.019 mm for decreasing the backlash by 0.01 mm.

(Note)
Gradually thin the shim plate to avoid excessive thinning of it.

6-8-1 Clamping mechanism (rotating axis) Mfg. #1051 and larger

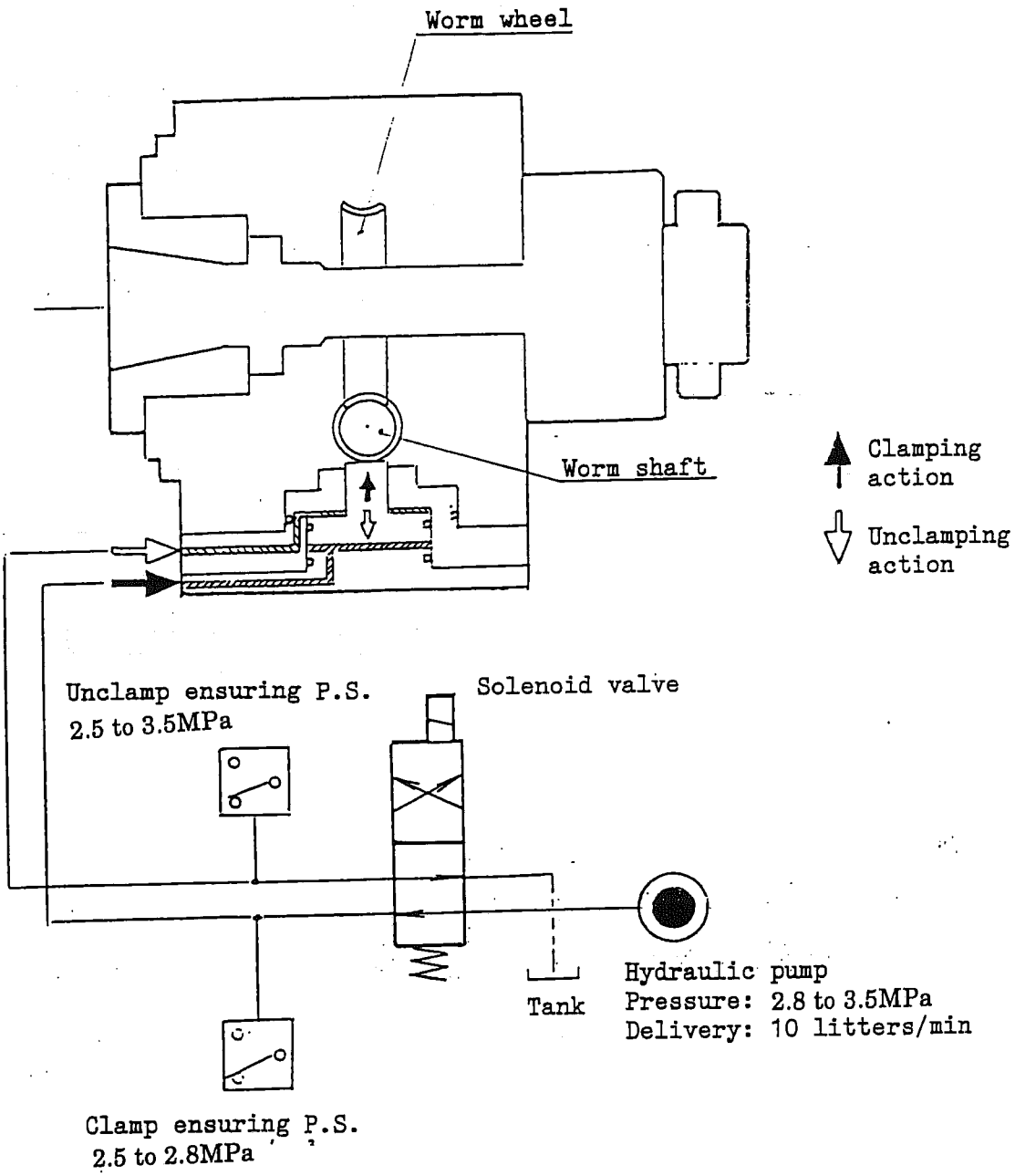
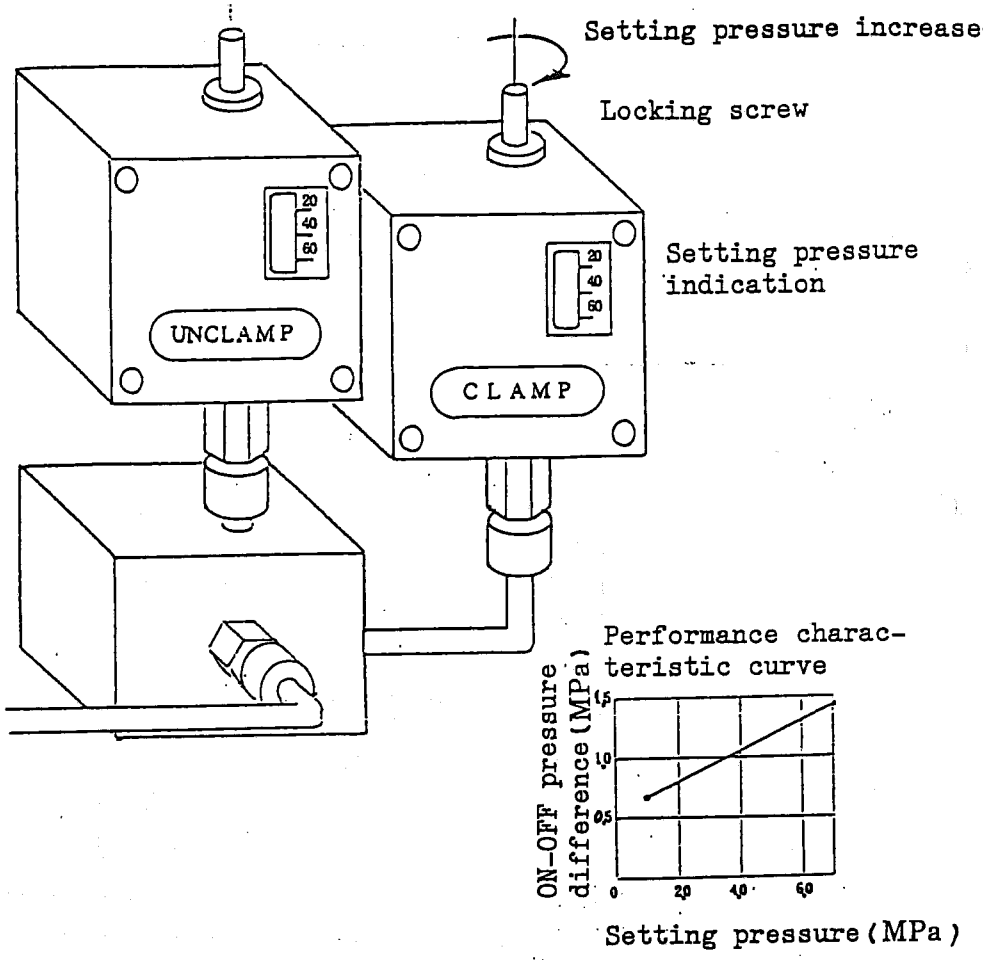


Fig. 17

The clamping mechanism for rotating axis is illustrated in Fig. 17. This mechanism is of a type which makes the backlash to "zero" by lifting up the worm shaft when clamping the table.

6-8-4 Handling of pressure switch (HW1-3T1-02, TYOOKI make)



The pressure switches for Mfg. No. #1025 and after have been changed as follows:

From JP-B1 and JP-B2, SANYO make (conventional)

to HW1-3T1-02, TOYOOKI make (new)

6-9 Mechanism of zero-point return (rotating axis)

The limit switch for reducing zero-point return speed is installed at the backside of the table at tail-stock side.

For adjustment of dog position, bring the dog to a position where the adjusting work can be done easily. Loosen the dog fastening screws and move the dog to an appropriate position.

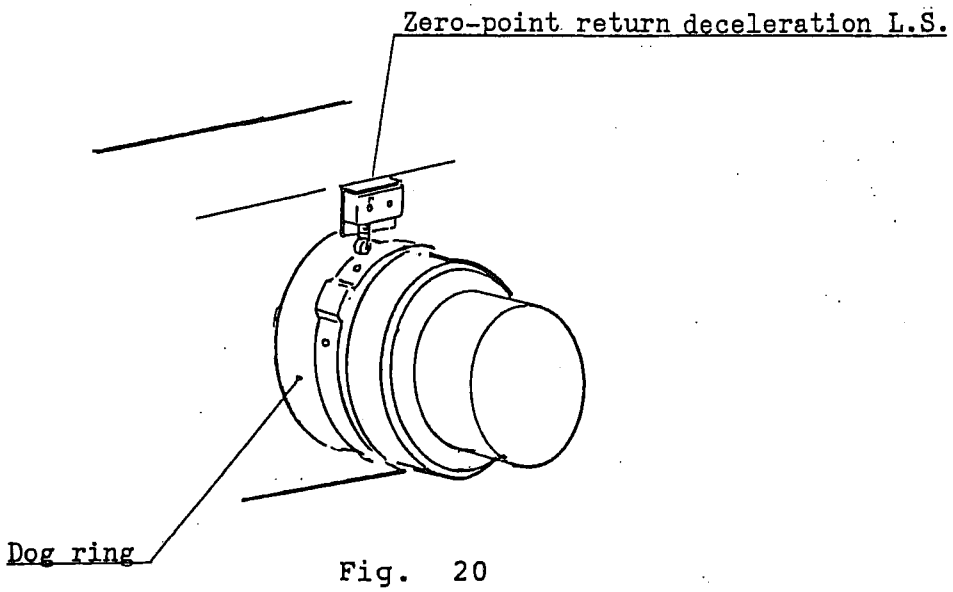


Fig. 20